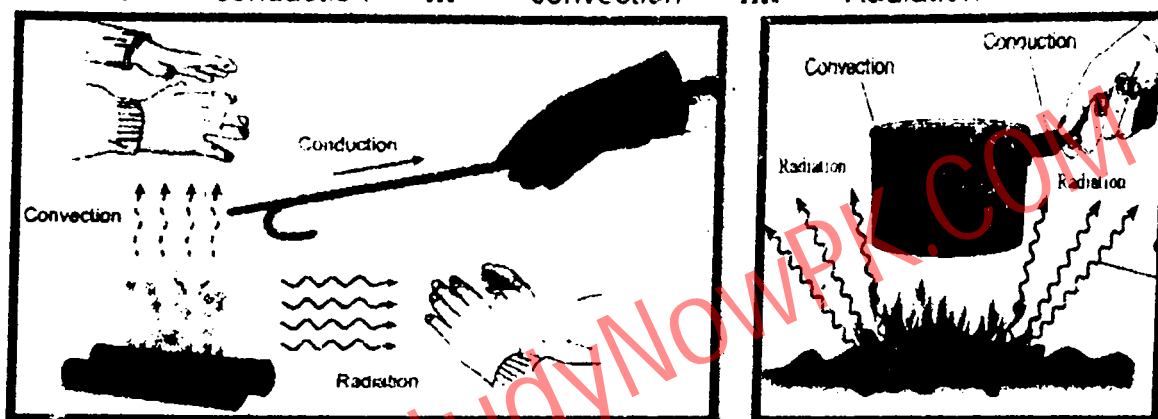
UNIT # 9
TRANSFER OF HEAT

Q1. List the three names by which heat can transfer from one place to another place?

Ans: Transfer of heat:

Thermal energy from a hot body flows to a cold body in the form of heat. This is called as transfer of heat. There are three ways by which transfer of heat takes place. These are:

i. conduction **ii.** convection **iii.** Radiation

Three ways of heat transfer

QUICK QUIZ

Think of objects around us getting heat or giving out heat.

Ans: **(i)** Melting of ice cubes. Ice cube gets heat from the surroundings.
(ii) A hot piece of iron radiate heat.
(iii) A black surface absorbs heat.
(iv) The glass of green house get heat from sun.

Q2. What is meant by conduction?

OR

Describe in terms of molecules and electrons how heat transfer occurs in solids

Ans: Conduction:

The mode of transfer of heat by vibrating atoms and free electrons in solids from hot to cold parts of a body is called conduction of heat.

Explanation:

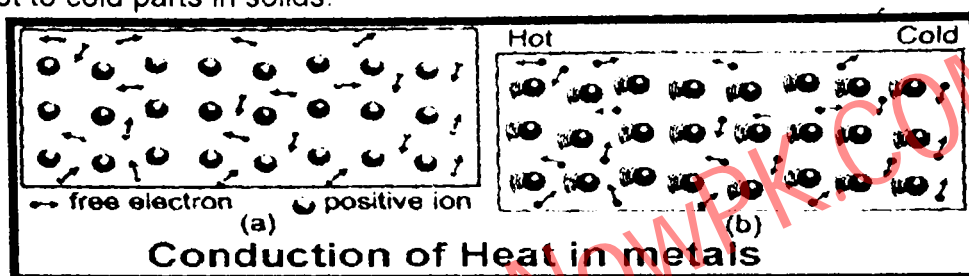
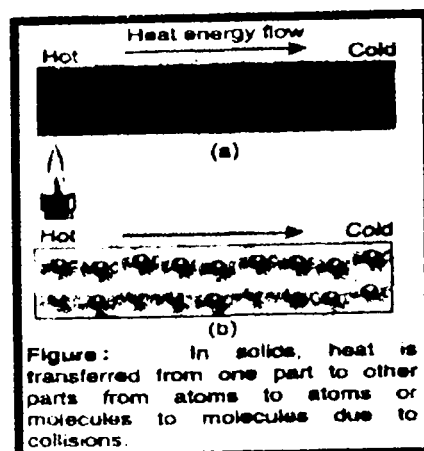
The handle of metal spoon held in hot water soon gets warm. But in case of a wooden spoon, the handle does not get warm. Both the materials behave differently regarding the transfer of heat. Both metals and non-metals conduct heat. Metal are generally better conductors than non-metals.

Conduction in solids:

Transfer of heat takes place from hot to cold parts in solids:

In solids, atoms and molecules are packed close together. They continue to vibrate about their mean position. When one end of a solid is heated then the atoms or molecules present at that end begin to vibrate more rapidly. They also collide with their neighbouring atoms or molecules. In doing so, they pass some of their energy to neighbouring atoms or molecules during collisions with them with the increase in their vibrations. These atoms or molecules in turn pass on a part of the energy to their neighbouring particles. In this way some heat reaches the other parts of the solids. This is a slow process and very small transfer of heat takes place from hot to cold parts in solids.

Figure: In solids, heat is transferred from one part to other parts from atoms to atoms or molecules to molecules due to collisions.

Conduction of Heat in metals

Q3. How does then heat flow from hot to cold parts in metals so rapidly than non-metals?

Ans: Metals have free electrons. These free electrons move with very high velocities within the metal objects. They carry energy at a very fast rate from hot to cold parts of the object as they move. Thus, heat reaches the cold parts of the metal objects from its hot part much more quickly than non-metals.

All metals are good conductors of heat.

Bad conductors or insulators:

The substances through which heat does not conduct easily are called bad conductors or insulators. Wood, cork, cotton, wool, glass, rubber, etc. are bad conductors or insulators.

DO YOU KNOW?

Why Styrofoam boxes are used to keep food hot or ice cream cold for a long time? Styrofoam is a bad conductor of heat. It does not allow heat to leave or enter the box easily.

Q4. Derive relation for thermal conductivity of a substance?

Ans: Thermal conductivity:

Let two opposite faces each of cross-sectional area A is heated to a temperature T_1. Heat Q flows along its length L to opposite face at temperature T_2 in t seconds.

The amount of heat that flows in unit time is called the rate of flow of heat.

Thus Rate of flow of heat $= \frac{Q}{t}$ (i)

It is observed that the rate at which heat flows through a solid object depends upon various factors.

Cross-sectional area of the solid:

Larger cross-sectional area *A* of a solid contains larger number of molecules and free electrons on each layer parallel to its cross-sectional area and hence greater will be the rate of flow of heat through the solid. Thus

Rate of flow of heat $\frac{Q}{t} \propto A$ (ii)

Figure Rate at which heat conducts through different solids depends upon various factors.

Length of the solid:

Larger is the length between the hot and cold ends of the solid, more time it will take to conduct heat to the colder end and smaller will be the rate of flow of heat. Thus

Rate of flow of heat $\frac{Q}{t} \propto \frac{1}{L}$ (iii)

Temperature difference between ends:

Greater is the temperature difference $T_1 - T_2$ between hot and cold faces of the solid, greater will be the rate of flow of heat. Thus

Rate of flow of heat $\frac{Q}{t} \propto (T_1 - T_2)$ (iv)

Combining the above factors, ii, iii, iv we get

$$\frac{Q}{t} \propto \frac{A(T_1 - T_2)}{L}$$

Rate of flow of heat $\frac{Q}{t} = \frac{kA(T_1 - T_2)}{L}$ (v)

Here k is the proportionality constant called thermal conductivity of the solid.

$$k = \frac{Q}{t} \times \frac{L}{A(T_1 - T_2)} \quad \text{(vi)}$$

Coefficient of thermal conductivity:

Thus, thermal conductivity of a substance can be defined as:

The rate of flow of heat across the opposite faces of a metre cube of a substance maintained at a temperature difference of one kelvin is called the thermal conductivity of that substance.

Unit of thermal conductivity:

$Wm^{-1}K^{-1}$ or $Jm^{-1}K^{-1}s^{-1}$

Q5. Describe the uses of conductors and non-conductors with examples?

Ans: Use of conductors and non-conductors:

In houses, good thermal insulation means lower consumption of fuel. For this, following measures may be taken to save energy.

- Hot water tanks are insulated by plastic or foam lagging.
- Wall cavities are filled with plastic foam or wool.
- Ceiling of rooms is covered by insulating materials (false ceiling).
- Double glazed window panes are used. These window panes have air between glass sheets that provides good insulation.

Uses of good conductor:

Good conductors are used when quick transfer of heat is required through a body. Thus cookers, cooking plate, boiler, radiators and condensers of refrigerators, etc. are made of metals such as aluminum or copper. Similarly, metal boxes are used for making ice, ice cream, etc.

Uses of Insulators or bad conductors:

Insulators or bad conductors are used in home utensils such as handles of sauce-pans, hot plates, spoons, etc. They are made up of wood or plastic. Air is one of the bad conductors or best insulator. That is why cavity walls i.e. two walls separated by an air space and double glazed windows keep the houses warm in winter and cool in summer. Materials which trap air i.e. wool, felt, fur, feathers, polystyrenes, fibre glass are also bad conductors. Some of these materials are used for laggings to insulate water pipes, hot water cylinders, ovens, refrigerators, walls and roofs of houses. Woollen cloth is used to make warm winter clothes.

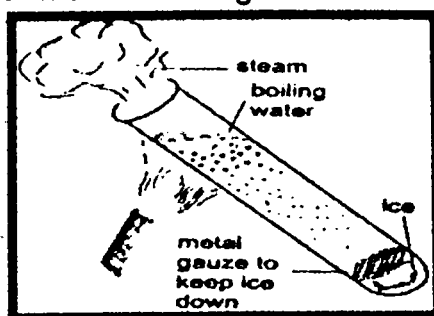
Soft insulation board is used between external brick wall of a house.

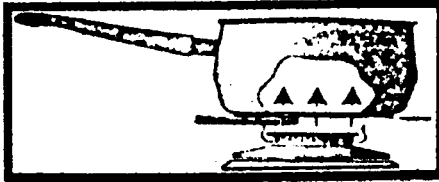
Q6. List the Thermal conductivities of some substances?

Ans: Thermal conductivities of some substances are given in the table.

Thermal conductivities of some common substances	
Substance	**$Wm^{-1} K^{-1}$**
Air (dry)	0.026
Aluminum	245
Brass	105
Brick	0.6
Copper	400
Glass	0.8
Ice	1.7
Iron	85
Lead	35
Plastic foam	0.03
Rubber	0.2
Silver	430
Water	0.59
Wood	0.08

FOR YOUR INFORMATION

Water is a poor conductor. Water at the top in the test tube starts boiling after getting heat from the burner without melting ice.

DO YOU KNOW?

Sauce-pans are made of metal for quick heat transfer.

DO YOU KNOW?

Feathers give good thermal insulation especially when fluffed up.

Q7. What is meant by convection current?

OR

Explain convection in seawater to support marine life.

OR

Describe convection in water heating by putting a few pinky crystals in a round bottom flask.

Ans: Convection:

Transfer of heat by actual movement of molecules from hot place to a cold place is known as convection.

Liquids and gases are poor conductors of heat. However, heat is transferred through fluids (liquids or gases) easily by another method called convection.

Experiment:

Take a beaker and fill two-third of it with water. Heat the beaker by keeping a burner below it. Drop two or three crystals of potassium permanganate ($KMnO_4$) in the water. It will be seen that coloured streaks of water formed by the crystals move upwards above the flame and then move downwards from side ways. These coloured streaks show the path of currents in the liquid. When the water at the bottom of the beaker gets hot, it expands, becomes lighter and rises up. While the cold but denser water moves downward to take its place.

Convection currents in air:

Gases also expand on heating, thus convection currents are easily set up due to the differences in the densities of air at various parts in the atmosphere.

Use of convection currents:

Convection currents set up by electric, gas or coal heaters help to warm our homes and offices. Central heating systems in buildings work on the same principle by convection. Convection currents occur on a large scale in nature. The day-to-day temperature changes in the atmosphere result from the circulation of warm or cold air that travels across the region. Land and sea breezes are also the examples of convection currents.

Q8. Why a balloon inflated with hot air is rises up?

Ans: A liquid or a gas becomes lighter (less dense) as it expands on heating. Hot liquid or gas rises up above the heated area. The cooler liquid or gas from the surroundings fills the place which in turns is heated up. In this way, all the fluid is heated up. Therefore, transfer of heat through fluids takes place by the actual movement of heated molecules from hot to cold parts of the fluid.

Q9. Why does sea breeze blow during the day? Why does land breeze blow in the night?

Ans: Land and sea breezes:

Land and sea breezes are the result of convection. On a hot day, the temperature of the land increases more quickly than the sea. It is because the specific heat of land is much smaller as compared to water. The air above land gets hot and rises up. Cold air from the sea begins to move towards the land it is called sea breeze.

At night, the land cools faster than the sea. Therefore, air above the sea is warmer, rises up and the cold air from the land begins to move towards the sea it is called land breeze.

Q10. How do the land and sea breezes help to keep the temperature moderate in coastal areas?

Ans: Sea Breezes:

The sea has a greater heat capacity than land and can therefore absorb more heat than the land, so the surface of the sea warms up more slowly than the land 's surface. As the temperature of the surface of the land rises, the land heats the air above it. The warm air is less dense and so it rises. This rising air over the land lowers the sea level pressure by about 0.2%. The cooler air above the sea, now with higher sea level pressure, flows towards the land into the lower pressure, creating a cooler breeze near the coast. The strength of the sea breeze is directly proportional to the temperature difference between the land and the sea.

Land Breezes:

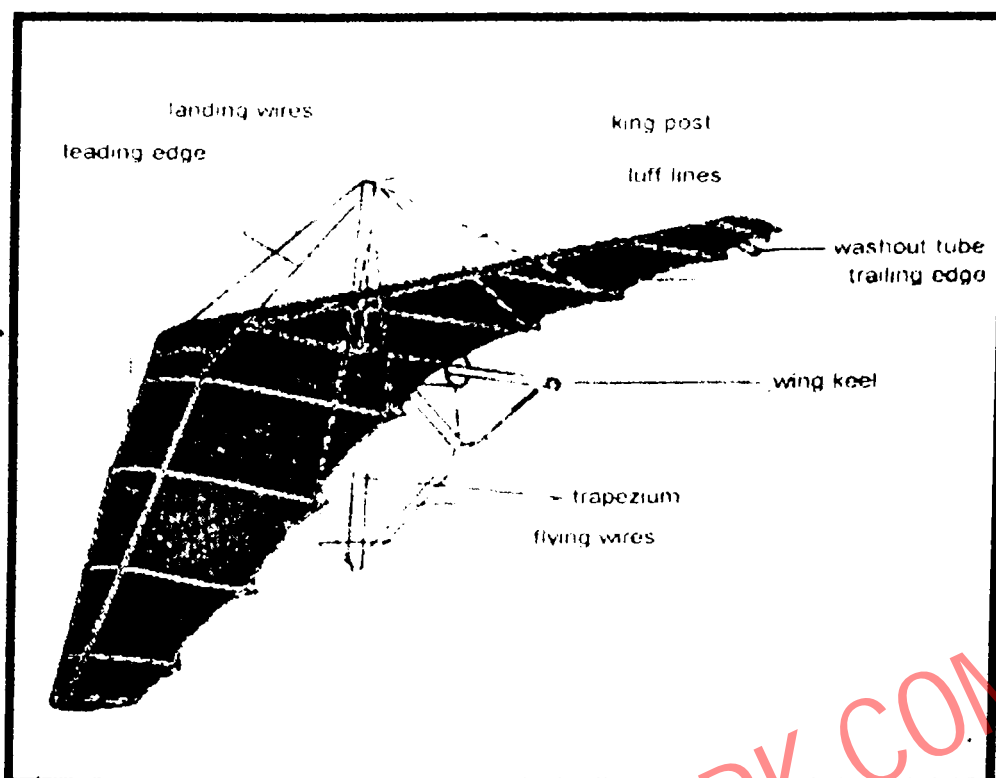
Land breezes usually occur at night. During the day, the sun will heat land surfaces, but only to a depth of a few inches. At night, water will retain more of its heat than land surfaces. Water has a high heat capacity which is one reason hurricane season At night, the temperature of the land cools quickly The water along the shore will then be warmer than the coastal land creating a net movement of air from the land surfaces towards the ocean.

Q11. What causes a glider to remain in air?

OR

Explain how the birds are able to fly for hours without flapping their wings and glider is able to rise by riding on thermal currents which are streams of hot air rising in the sky.

Ans: Gliding:

A glider looks like a small aeroplane without engine. Glider pilots use upward movement of hot air currents due to convection of heat. These rising currents of hot air are called **thermals**. Gliders ride over these thermals. The upward movement of air currents in thermals help them to stay in air for a long period.

Q12. How do thermals help birds to fly for hours without flapping their wings?

Ans: The birds stretch out their wings and circle in these thermals. The upward movement of air helps birds to climb up with it. Eagles, hawks and vultures are expert **thermal climbers**. After getting a free lift, birds are able to fly for hours without flapping their wings. They glide from one thermal to another and thus travel through large distances and hardly need to flap their wings.

Q13. How does heat reach us from the Sun?

OR

Explain the process of radiation?

OR

Explain that energy transfer of a body by radiation does not require a material medium and rate of energy transfer is affected by:

i. Colour and texture of the surface

ii. Surface temperature

iii. Surface area

Ans: Radiation:

Radiation is the mode of transfer of heat from one place to another in the form of waves called electromagnetic waves.

Transfer of heat energy from sun to the earth:

Our Sun is the major source of heat energy. Sun light reaches us neither by conduction nor by convection, because the space between the Sun and the Earth's atmosphere is empty. There is a third mode called radiation by which heat travels from one place to another. It is through radiation that heat reaches us from the Sun.

Q14. Why does a cup of hot tea become cold after sometime?

Ans: When temperature of an object (cup of hot tea) is higher than its surroundings then it is radiating more heat than it is absorbing. As a result, its temperature goes on decreasing till it becomes less than surroundings.

Therefore a cup of hot tea becomes cold after sometime.

Q15. Why does a glass of chilled (frozen) water become hot after sometime?

Ans: When temperature of an object (chilled water) is lower than its surroundings, then it is radiating less heat than it is absorbing. As a result, its temperature goes on increasing till it becomes equal to its surroundings. That is why a glass of chilled (frozen) water become hot after sometime.

Q16. How various surfaces can be compared by a Leslie cube?

OR

Investigate the absorption of radiation by a black surface and silvery surfaces using Leslie cube. Also investigate the emission of radiation by a black surface and silvery surfaces using Leslie cube.

OR

Explain how rate of energy transfer is affected by:

i. Colour and texture of the surface
ii. Surface temperature
iii. Surface area

Ans: See Q # 9.10 from exercise.

Q17. How does heat reach us directly from a fireplace?

Ans: Heat does not reach us by conduction through air from a fireplace because air is a poor conductor of heat. Heat does not reach us by convection because the air getting heat from the fireplace does not move in all directions. Hot air moves upward from the fireplace. Heat from the fireplace reaches us directly by a different process in the form of waves called radiation. A sheet of paper or cardboard kept in the path of radiations stop these waves to reach us.

Q18. What is greenhouse effect?

OR

Explain the consequence of heat radiation in greenhouse effect and its effect in global warming.

OR

How does the temperature in a greenhouse can be maintained?

Ans: See Q # 9.11 from exercise.

Q19. Explain the impact of greenhouse effect in global warming.

Ans: See Q # 9.12 from exercise.

Q20. Explain application and consequences of radiation?

Ans: Application and consequences of radiation:

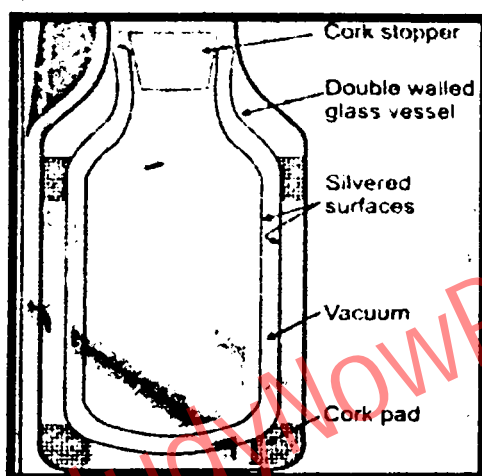
A black and rough surface absorbs more heat than a white or polished surface. Since good absorbers are also good radiators of heat. Thus, a black coloured body gets hot quickly absorbing heat reaching it during a sunny day and also cools down quickly by giving out its heat to its surroundings.

The bottoms of cooking pots are made black to increase the absorption of heat from fire.

White surfaces reflect more than coloured or black surfaces. Similarly, polished surfaces are good reflectors than rough surfaces and reflection of heat radiations is greater from polished surfaces. Hence, we wear white or light coloured clothes in summer which reflect most of the heat radiation reaching us during the hot day.

We polish the interior of the cooking and hot pots for reflecting back most of the heat radiation within them.

FOR YOUR INFORMATION

In a thermos flask, most of the heat is prevented to enter or leave the flask. This is done by suitable measures to reduce the transfer of heat due to conduction, convection and radiation. Thus, anything kept in it, maintains its temperature for a long time.

SUMMARY

1. Heat flows from a body at higher temperature to a body at lower temperature.
2. There are three ways of heat transfer. These are conduction, convection and radiation.
3. **Conduction of heat:** The mode of transfer of heat by vibrating atoms and free electrons in solids from hotter to colder part of a body is called conduction of heat.
4. **Rate of flow of heat:** The amount of heat that flows in unit time is called the rate of flow of heat.
5. The rate at which heat flows through solids depends on the cross-sectional area of the solid, length between hot and cold ends, temperature difference between hot and cold ends and nature of the material.
6. **Thermal conductivity:** The rate of flow of heat across the opposite faces of a metre cube maintained at a difference of 1 K is called the thermal conductivity of the material of the cube.

7. Good conductors are used for quick transfer of heat. Thus cookers, cooking plate, boiler, radiators and condensers of refrigerators etc. are made of metals.
8. Water is a poor conductor of heat.
9. Materials which trap air are also bad conductors such as wool, felt, fur, feathers, polystyrenes and fibre glass.
10. **Convection:** Transfer of heat by actual movement of molecules from hot place to a cold place is known as convection.
11. Land and sea breezes are also the examples of convection.
12. Gliders use upward movement of hot air currents due to convection of heat. Air currents help them to stay in air for a long period.
13. Birds are able to fly for hours without flapping their wings due to the upward movement of air currents.
14. The term radiation means the continual emission of energy from the surface of a body in the form of electromagnetic waves.
15. Radiations are emitted by all bodies. The rate at which radiations are emitted depends on various factors such as colour and texture of the surface, temperature and surface area.
16. A dull black surface is a good absorber of heat as its temperature rises rapidly.
17. A polished surface is poor absorber of heat as its temperature rises very slowly.
18. **Green House:** Radiations from the Sun pass easily through glass/polythene and warms up the materials inside a greenhouse. The radiations given out by them are of much longer wavelengths. Glass/polythene does not allow them to escape out and thus maintains the inside temperature of the greenhouse.
19. Earth's atmosphere contains carbon dioxide and water vapours. It causes greenhouse effect and thus retains the temperature of the Earth.
20. The bottoms of cooking pots are made black to increase the absorption of heat from fire.
21. White surfaces reflect more heat than coloured or black surfaces. Similarly, polished surfaces are good reflectors than rough surfaces and reflection of heat radiations is greater from polished surfaces. Therefore, we wear white or light coloured clothes in summer
22. We polish the interior of the cooking pots for reflecting back most of the heat radiation inside the hot pots.
23. **Thermos flask:** A thermos flask consists of a double-walled glass vessel. It reduces the transfer of heat by conduction, convection and radiation.

QUESTIONS

9.1 Encircle the correct answer from the given choices:

i. In solids, heat is transferred by:

A. radiation
B. conduction
C. convection
D. absorption

ii. **What happens to the thermal conductivity of a wall if its thickness is doubled?**
A. becomes double
B. remains the same
C. becomes half
D. becomes one fourth

iii. **Metals are good conductor of heat due to the:**
A. free electrons
B. big size of their molecules
C. small size of their molecules
D. rapid vibrations of their atoms

iv. **In gases, heat is mainly transferred by**
A. conduction
B. conduction
C. convection
D. radiation

v. **Convection of heat is the process of heat transfer due to the:**
A. random motion of molecules
B. downward movement of molecules
C. upward movement of molecules
D. free movement of molecules

vi. **False ceiling is done to**
A. lower the height of ceiling
B. keep the roof clean
C. cool the room
D. insulate the ceiling

vii. **Rooms are heated using gas heaters by**
A. Conduction only
B. Convection and radiation
C. Radiation only
D. Convection only

viii. **Land breeze blows from**
A. sea to land during night
B. sea to land during the day
C. land to sea during night
D. land to sea during the day

ix. **Which of the following is a good radiator of heat?**
A. a shining silvered surface
B. a dull black surface
C. a white surface
D. a green coloured surface

Answers

i. B	ii. C	iii. A	iv. C	v. C
vi. D	vii. B	viii. C	ix. B	

9.2 Why metals are good conductors of heat?

Ans: Metals are good conductors of heat because of the valence electrons' freedom of motion within a metal. The free-moving electrons transmit heat quickly.

9.3 Explain why:

(a) a metal feels colder to touch than wood kept in a cold place?
(b) land breeze blows from land towards sea?
(c) double walled glass vessel is used in thermos flask?
(d) deserts soon get hot during the day and soon get cold after sunset?

Ans: (a) a metal feels colder to touch than wood kept in a cold place?

Metal is a thermal conductor and Wood is a thermal insulator. When you touch the metal, the energy transfers rapidly to the metal, making it colder. When you touch the wood, the energy transfers very slowly from your hand to the wood. That is why a metal feels colder to touch than wood kept in a cold place.

(b) land breeze blows from land towards sea?

In the night, land cools down much quicker than does the waters of the ocean. As the land becomes cooler, so does the air above it. This results in air becoming more dense, forming a high pressure, causing winds to blow outward towards the sea. This is known as a land breeze.

Thus, in the day we often see sea breezes, while in the evening we see land breezes in coastal regions.

(c) double walled glass vessel is used in thermos flask?

A vacuum flask consists of 3 vessels. One is the outer casing which simply holds the inner, double walled glass vessel which is brightly silvered, both inside and outside. The inside silvered lining reflects heat back into the hot liquid inside (or prevents heat entering into a cold liquid). The outer wall is also silvered on both sides for the same reason.

Between the two walls, which are sealed together at the top and bottom, is a Vacuum (a very low pressure) which has very few particles (molecules) through which neither conduction nor convection will easily take place. (These forms of Heat Transfer need particles by which they will transfer the heat). However, radiated heat will pass through a vacuum. This is where the silvered surfaces come into use.

(d) deserts soon get hot during the day and soon get cold after sunset?

In deserts sand has low specific heat that is why it will soon get heated or cooled. Hence desert nights are colder whereas the days are very hot.

9.4 Why conduction of heat does not take place in gases?

Ans: Because the space between particles is farther apart when in either the gas or liquid state. Solid substances' particles are very close to together, whereas gas particles will actually move are far apart as possible. When the particles are farther apart, it makes the transfer of energy much less efficient. That is why conduction of heat does not take place in gases.

9.5 What measures do you suggest to conserve energy in houses?

Ans:

i. Check your filters on your heating systems monthly. Remove, clean or change when needed.

ii. Make sure your walls on fully insulated. This cuts down on the amount of energy your home needs to keep it warm and cool.

iii. Looks for cracks in your walls, around your windows and doors. Seal them with weather-stripping or caulking. Even the smallest hole will loose a great amount of energy over time.

iv. Open your curtains and allow the sun to filter inside your home. The sun can actually warm your house. At night, especially, when it is cold close your curtains to keep in your heat. Use insulated curtains.

v. Only cool and heat rooms that actually need it.

vi. Clean the back of your refrigerator where the coils are once in a week. Use a brush to remove the dust. Be sure to unplug your refrigerator while doing this.

vii. Keep your refrigerator away from heated appliances such as dishwashers and heating ducts. If the refrigerator is near heat forces it will cause the refrigerator to work harder and thus run longer.

viii. Save energy by washing your clothes in warm water instead of hot. You can also save energy by rinsing your clothes in the cold cycle. You can even wash many clothes in cold water today, by buying special detergents made for cold water.

ix. Turn lights off when not in use.

If we all follow these tips on a regular basis, over time they will add up and save a huge amount of energy.

9.6 Why transfer of heat in fluids takes place by convection?

Ans: Convection takes place in fluids (liquids or gases). As a fluid is heated, the molecules increase in motion and the fluid begins to expand - molecules move further apart. This gives a decrease in density which causes the hotter fluid to rise and the cool fluid to fall, setting up a circulation within the fluid. The heat energy is gradually increased throughout the fluid.

This method of heat transfer is seen in the use of Space Heating and in heat distribution in a furnace. Convection can take place by the natural currents set up by the application of heat or increased heat transfer by mechanical means forced convection as when a fan or pump is used.

9.7 What is meant by convection current?

Ans: The flow that transfers heat within a fluid is called a convection current. When you heat water, the molecules that are cold are heavy or dense, so they sink to the bottom. But the hot ones are less dense, so they go up. As they go up, they get cold and also get heavy. So they sink down and the cycle goes on and on this process will continue due to convection current.

9.8 Suggest a simple activity to show convection of heat in gases not given in the book.

Ans: Convection is the is the (circular) movement of heat through a fluid such as air or water. The movement occurs because the heat energy causes the fluid molecules to "spread out" with an excited state of energy. This "spreading out" causes the heated fluid to become less dense than the surrounding fluid, so it rises. As the energy dissipates it's gains density again and starts to settle back down.

Activity:

So, in your example, the flame at the bottom of the oven heats the surrounding air which circulates (convects) inside the oven and transfers energy to the food. Once the heat hits the food, the inside of it gets cooked by conduction.

9.9 How does heat reach us from the Sun?

Ans: Sunlight or Solar Radiation is essentially photons, or packets of energy, emmited from the sun's surface, which are able to travel through the vacuum of space at the speed of light by the process of radiation. This comes to us in a range of wavelengths, including Visible light, Ultra violet and Infra red radiation.

9.10 How various surfaces can be compared by a Leslie cube?

Ans: Ans: The rate at which various surfaces emit heat depends upon the nature of the surface. Various surfaces can be compared using Leslie's cube.

Emission and Absorption of Radiation:

A Leslie cube is a metal box having faces of different nature. The four faces of Leslie's cube may be as follows:

A shining silvered surface A dull black surface

- A white surface
- A coloured surface

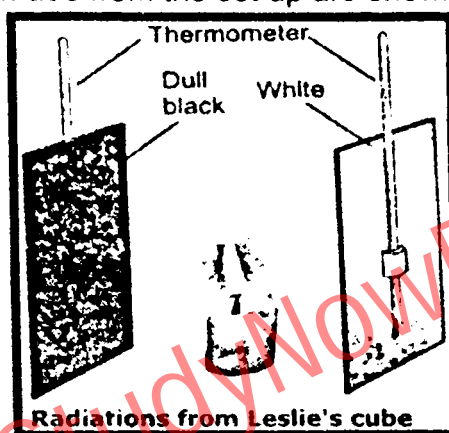
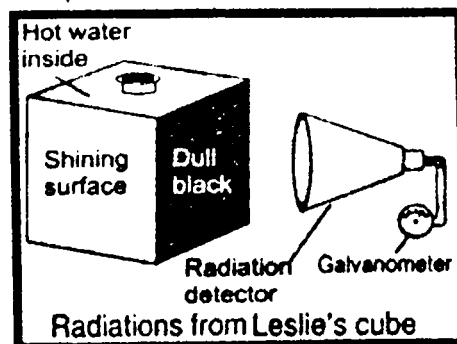
Hot water is filled in the Leslie's cube and is placed with one of its face towards a radiation detector. It is found that black dull surface is a good emitter of heat.

Radiations from Leslie's cube

The rate at which various surfaces absorb heat also depends upon the nature of those surfaces. For example, take two surfaces, one is dull black and the other is a silver polished surface as shown in figure 9.16 with a candle at the middle of the surface. It is found that:

A dull black surface is a good absorber of heat as its temperature rises rapidly.

A polished surface is poor absorber of heat as its temperature rises very slowly. The observations made from the set up are shown in the table given below:

Radiations from Leslie's cube

Surfaces	Emitter	Absorber'	Reflector
dull black surface	best	best	worst
coloured surface	good	good	bad
White surface	bad	bad	good
shining silvered surface	worst	worst	best

It is also found that the transfer of heat by radiation is also affected by the surface area of the body emitting or absorbing heat. Larger is the area, greater will be the transfer of heat. It is due to this reason that large numbers of slots are made in radiators to increase their surface area. $Q \propto A$

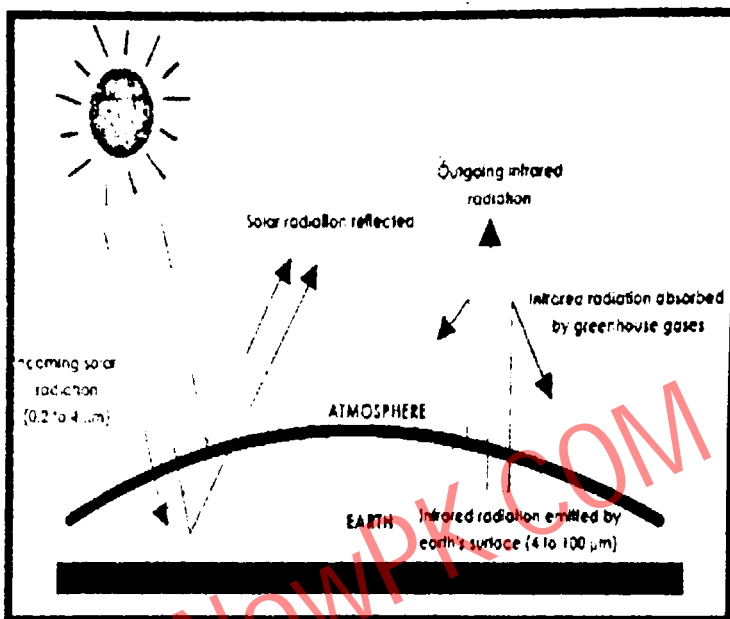
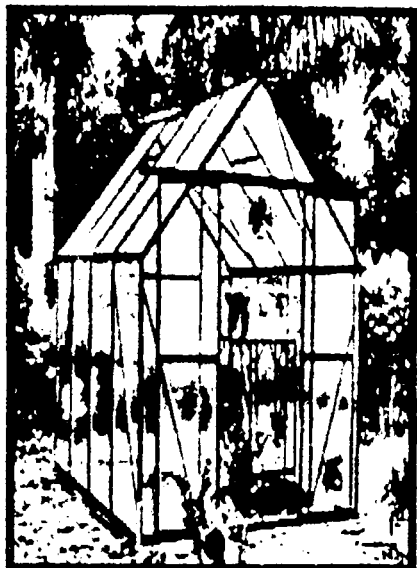
9.11 What is greenhouse effect?

Ans: Greenhouse effect:

Warming that results when solar radiation is trapped by the atmosphere; caused by atmospheric gases that allow sunshine to pass through but absorb heat that is radiated back from the warmed surface of the earth.

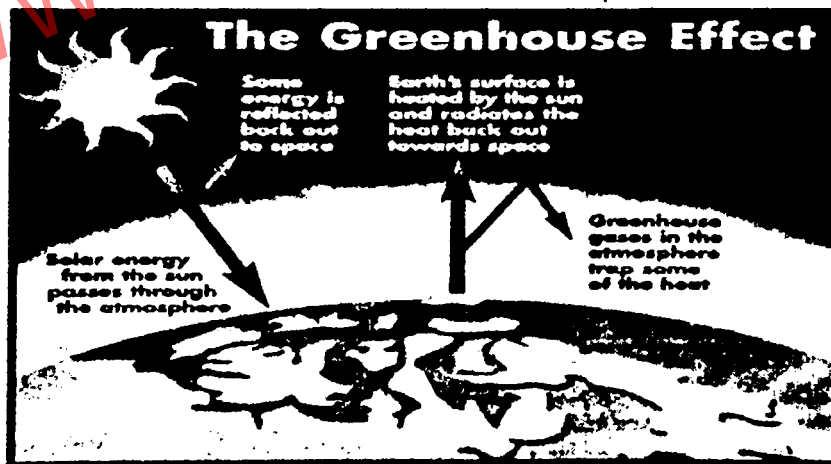
Explanation:

Light from the Sun contains thermal radiations (infrared) of long wavelengths as well as light and ultraviolet radiations of short wavelengths. Glass and transparent polythene sheets allow radiations of short wavelength to pass through easily but not long wavelengths of thermal radiations. Thus, a greenhouse becomes a heat trap.

Radiations from the Sun pass easily through glass and warms up the objects in a greenhouse. These objects and plants give out radiation of much longer wavelengths. Glass and transparent polythene sheets do not allow them to escape out easily and are reflected back in the greenhouse. This maintains the inside temperature of the greenhouse. Greenhouse effect promises better growth of some plants.

A greenhouse

9.12 Explain the impact of greenhouse effect in global warming.

Ans: Global warming:

Carbon dioxide and water also behave in a similar way to radiations as glass or polythene. Earth's atmosphere contains carbon dioxide and water vapours. It causes greenhouse effect and thus maintains the temperature of the Earth.

Greenhouse effect in global warming

During the recent years, the percentage of carbon dioxide has been increased considerably. This has caused an increase in the average temperature of the Earth by trapping more heat due to greenhouse effect. This phenomenon is known as global warming. This has serious implications for the global climate.

PROBLEMS

9.1 The concrete roof of a house of thickness 20 cm has an area 200 m^2. The temperature inside the house is 15°C and outside is 35°C. Find the rate at which thermal energy will be conducted through the roof. The value of k for concrete is $0.65 Wm^{-1}K^{-1}$. ($13000\ Js^{-1}$)

Solution: Thickness of the roof = L = 20 cm = $\frac{20}{100}$ = 0.2 m

Area = A = 200 m^2

Temperature outside the house = T_1 = 35°C = 35 + 273 = 308 K

Temperature inside the house = T_2 = 15°C = 15 + 273 = 288 K

Change in temperature = $\Delta T = T_1 - T_2$ = 308 - 288 = 20K

Value of conductivity for concrete = k = 0.65 $Wm^{-1}K^{-1}$

Rate of conduction of thermal energy = $\frac{Q}{t}$ = ?

$$\frac{Q}{t} = \frac{kA(T_1 - T_2)}{L}$$

$$\frac{Q}{t} = \frac{0.65 \times 200 \times 20}{0.2} = \frac{2600}{0.2} = 13000W$$

As ($1w = 1Js^{-1}$) therefore

$$\frac{Q}{t} = 1300Js^{-1}$$

9.2 How much heat is lost in an hour through a glass window measuring 2.0 m by 2.5 m when inside temperature is 25 °C and that of outside is 5 °C, the thickness of glass is 0.8 cm and the value of k for glass is 0.8 $Wm^{-1}K^{-1}$? ($3.6\times10^7 J$)

Solution: Time = t = 1 hour = 3600s

Area of a glass window = A = 2.0 m × 2.5 m = 5 m^2

Thickness of glass = L = 0.8 cm = $\frac{0.8}{100}$ m = 0.08 m

Inside temperature = T_1 = 25°C = 25 + 273 = 298 K

Outside temperature = T_2 = 5°C = 5 + 273 = 278 K

Change in temperature = $\Delta T = T_1 - T_2$ = 298- 278= 20 K

Value of conductivity for concrete = k = 0.8 $Wm^{-1}K^{-1}$

Heat lost = Q = ?

$$\frac{Q}{t} = \frac{kA(T_1 - T_2)}{L}$$

$$Q = \frac{kA(T_1 - T_2)}{L} \times t$$

$$Q = \frac{0.8 \times 5 \times 20}{0.008} \times 3600 = 3.6 \times \text{[illegible]}$$